We claim:

1. A bridged polysesquioxane composition comprising:

a bridged polysesquioxane host matrix comprising sesquioxane moieties and organic moieties, said sesquioxane moieties comprising a metallic element, said organic moieties interposed between sesquioxane moieties; and

a guest molecule comprising a lanthanide atom;

at least some of said organic moieties comprising a substituent selected from the group consisting of electron withdrawing functional groups and electron donating functional groups.

2. The composition of claim 1 in which said metallic element is selected from the group consisting of silicon, aluminum, titanium, zirconium, germanium, and mixtures.

3. The composition of claim 1 in which said guest molecule comprises an aromatic group.

4. The composition of claim 1 in which said lanthanide atom is selected from the group consisting of erbium, praseodymium, and neodymium.

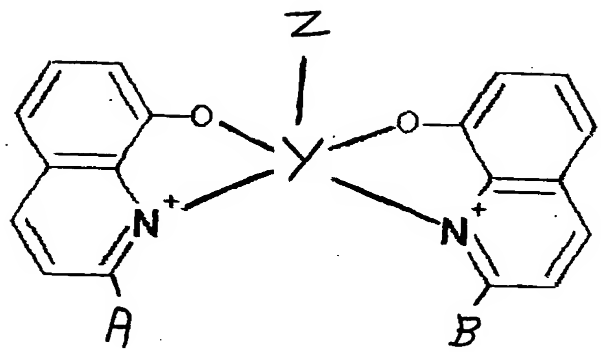
5. The composition of claim 1 further comprising semiconductor quantum-dot particles.

6. The composition of claim 1 comprising an electron withdrawing functional group that comprises an element selected from the group consisting of fluorine, chlorine, bromine and iodine.

7. The composition of claim 1 comprising an electron donating functional group that comprises an element selected from the group consisting of nitrogen, oxygen and phosphorus.

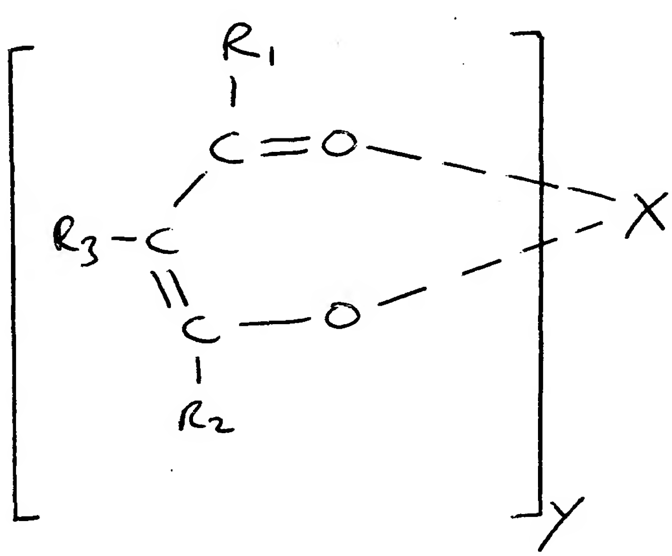
8. The composition of claim 2 in which said bridged polysesquioxane host matrix is a bridged polysilsesquioxane host matrix, and said sesquioxane moieties are silsesquioxane moieties.

9. The composition of claim 3 in which said guest molecule is a compound having Formula 1 below,



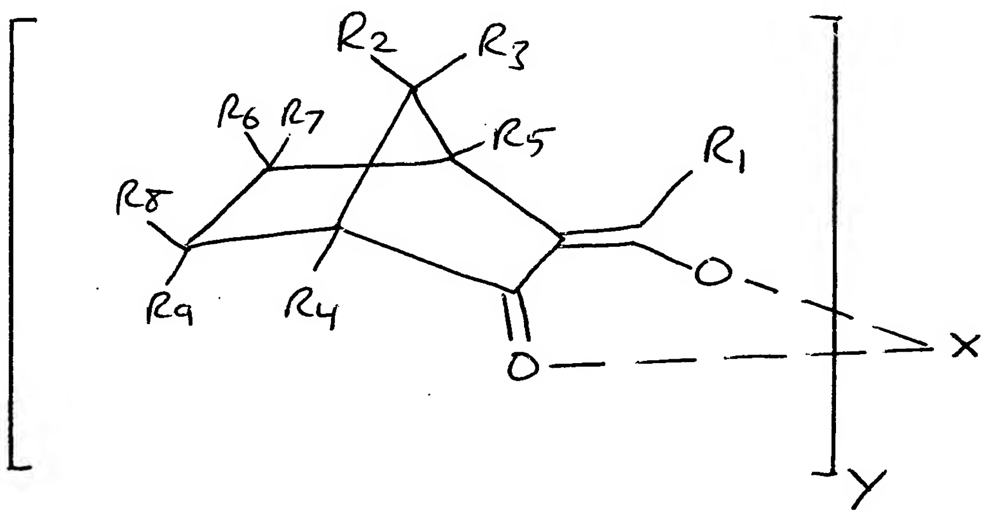
in which A and B independently can be hydrogen or -alkyl; Y is a lanthanide atom; and Z is an oxyaryl group.

10. The composition of claim 3 in which said guest molecule is a compound having Formula 2 below,



in which each of R_1 and R_2 independently can be a hydrocarbon moiety, or a hydrocarbon moiety comprising an electron withdrawing group; R_3 is an electron withdrawing group, a lower alkyl group, or hydrogen; X is a selected lanthanide metal; and Y is equal to the valence of the selected lanthanide metal.

11. The composition of claim 3 in which said guest molecule is a compound having Formula 3 below,



in which R_1 is a hydrocarbon moiety comprising an electron withdrawing group; each of R_2, R_3, R_4, R_5, R_6, R_7, R_8 and R_9 is hydrogen or a lower alkyl group; X is a selected lanthanide metal; and Y is equal to the valence of the selected lanthanide metal.

12. The composition of claim 6 in which said electron withdrawing functional group comprises a halogenated hydrocarbon moiety.

13. The composition of claim 7 in which said electron donating functional group is a member selected from the group consisting of -NR2, -NH2, -NRH, and -OR, in which R is methyl or ethyl.

14. The composition of claim 9 in which Z is an aromatic moiety selected from the group consisting of: phenolic, alkylphenolic, hydroxynaphthalenyl, alkylhydroxynaphthalenyl, 8-hydroxyquinolinyl, and alkyl- 8-hydroxyquinolinyl.

15. The composition of claim 12 in which said polysesquioxane host matrix is produced by polymerization of di(trialkoxy) monomers comprising at least about 38% by weight of fluorine.

16. The composition of claim 12 in which said polysesquioxane host matrix is produced by polymerization of di(trialkoxy) monomers comprising at least eight fluorine atoms.

17. A process for making a bridged polysesquioxane composition comprising the steps of:

providing a bridged polysesquioxane host matrix comprising sesquioxane moieties and organic moieties, said sesquioxane moieties comprising a metallic element, said organic moieties interposed between sesquioxane moieties; and

providing a guest molecule comprising a lanthanide atom;

at least some of said organic moieties comprising a substituent selected from the group consisting of electron withdrawing functional groups and electron donating functional groups.

18. The process of claim 17 in which said metallic element is selected from the group consisting of silicon, aluminum, titanium, zirconium and germanium.

19. The process of claim 17 in which said guest molecule comprises an aromatic group.

20. The process of claim 17 in which said lanthanide atom is selected from the group consisting of erbium, praseodymium, and neodymium.

21. The process of claim 17 further comprising semiconductor quantum-dot particles.

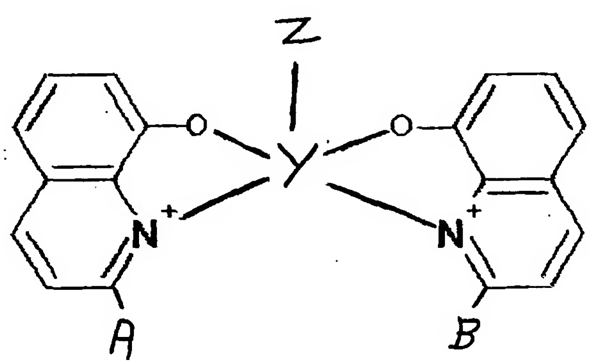
22. The process of claim 17 in which at least about 81 percent of silicon-containing moieties are condensed into sesquioxane moieties.

23. The process of claim 17 comprising an electron withdrawing functional group that comprises an element selected from the group consisting of fluorine, chlorine, bromine and iodine.

24. The process of claim 17 comprising an electron donating functional group that comprises an element selected from the group consisting of nitrogen, oxygen and phosphorus.

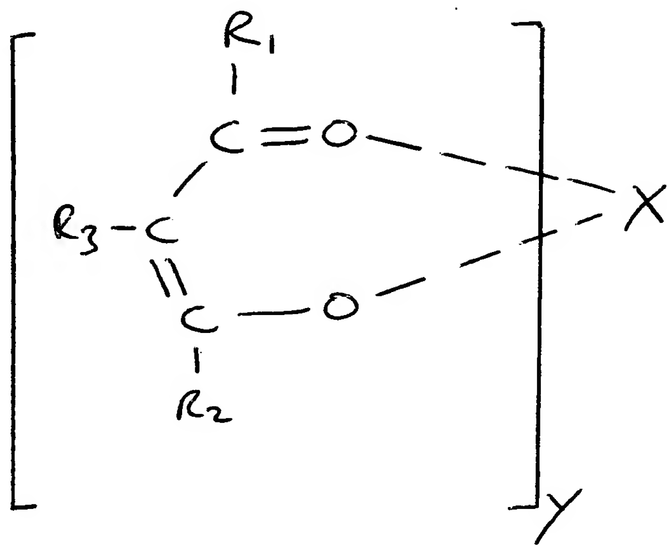
25. The process of claim 18 in which said bridged polysesquioxane host matrix is a bridged polysilsesquioxane host matrix, and said sesquioxane moieties are silsesquioxane moieties.

26. The process of claim 19 in which said guest molecule is a compound having Formula 1 below,



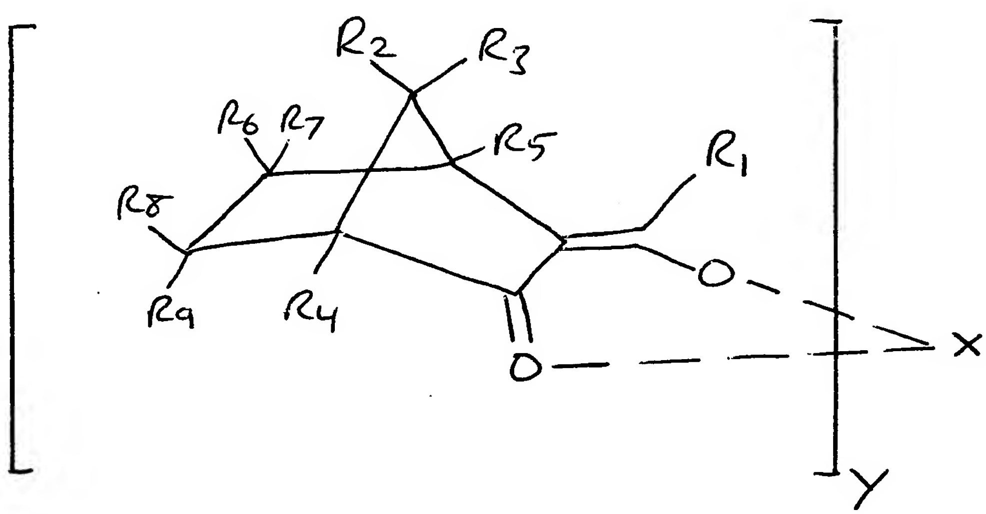
in which A and B independently can be hydrogen or -alkyl; Y is a lanthanide atom; and Z is an oxyaryl group.

27. The process of claim 19 in which said guest molecule is a compound having Formula 2 below,



in which each of R_1 and R_2 independently can be a hydrocarbon moiety, or a hydrocarbon moiety comprising an electron withdrawing group; R_3 is an electron withdrawing group, a lower alkyl group, or hydrogen; X is a selected lanthanide metal; and Y is equal to the valence of the selected lanthanide metal.

28. The process of claim 19 in which said guest molecule is a compound having Formula 3 below,



in which R_1 is a hydrocarbon moiety comprising an electron withdrawing group; each of R_2, R_3, R_4, R_5, R_6, R_7, R_8 and R_9 is hydrogen or a lower alkyl group; X is a selected lanthanide metal; and Y is equal to the valence of the selected lanthanide metal.

29. The process of claim 23 in which said electron withdrawing functional group comprises a halogenated hydrocarbon moiety.

30. The process of claim 24 in which said electron donating functional group is a member selected from the group consisting of -NR2, -NH2, -NRH, and -OR, in which R is methyl or ethyl.

31. The process of claim 26 in which Z is an aromatic moiety selected from the group consisting of: phenolic, alkylphenolic, hydroxynaphthalenyl, alkylhydroxynaphthalenyl, 8-hydroxyquinolinyl, and alkyl- 8-hydroxyquinolinyl.

32. The process of claim 29 in which said polysesquioxane host matrix is produced by polymerization of di(trialkoxy) monomers comprising at least about 38% by weight of fluorine.

33. The process of claim 29 in which said polysesquioxane host matrix is produced by polymerization of di(trialkoxy) monomers comprising at least eight fluorine atoms.

34. A gain medium comprising the composition of claim 1, in which the composition has a fluorescence peak that is capable of amplifying light within at least one wavelength range selected from the group consisting of 900-1000 nanometers, 1260-1360 nanometers, and 1500-1600 nanometers.

35. The gain medium of claim 34, comprising the composition of claim 9.

36. The gain medium of claim 34, comprising the composition of claim 10.

37. The gain medium of claim 34, comprising the composition of claim 11.

38. The gain medium of claim 34, comprising the composition of claim 15.

39. The gain medium of claim 34, suitably shaped for use in a fiber amplifier.

40. The gain medium of claim 34, suitably shaped for use in a planar waveguide amplifier.

41. An active material for an upconversion laser comprising the composition of claim 1, in which the composition has a fluorescence peak that is capable of amplifying light within at least one wavelength range selected from the group consisting of 900-1000 nanometers, 1260-1360 nanometers, and 1500-1600 nanometers.

42. The active material of claim 41, comprising the composition of claim 9.

43. The active material of claim 41, comprising the composition of claim 10.

44. The active material of claim 41, comprising the composition of claim 11.

45. The active material of claim 41, comprising the composition of claim 15.